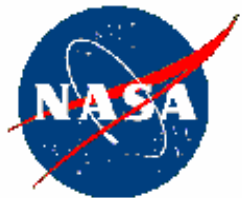


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# **Past X-Band Workshops Changes in Overall Band Usage Summary of Available Bands**

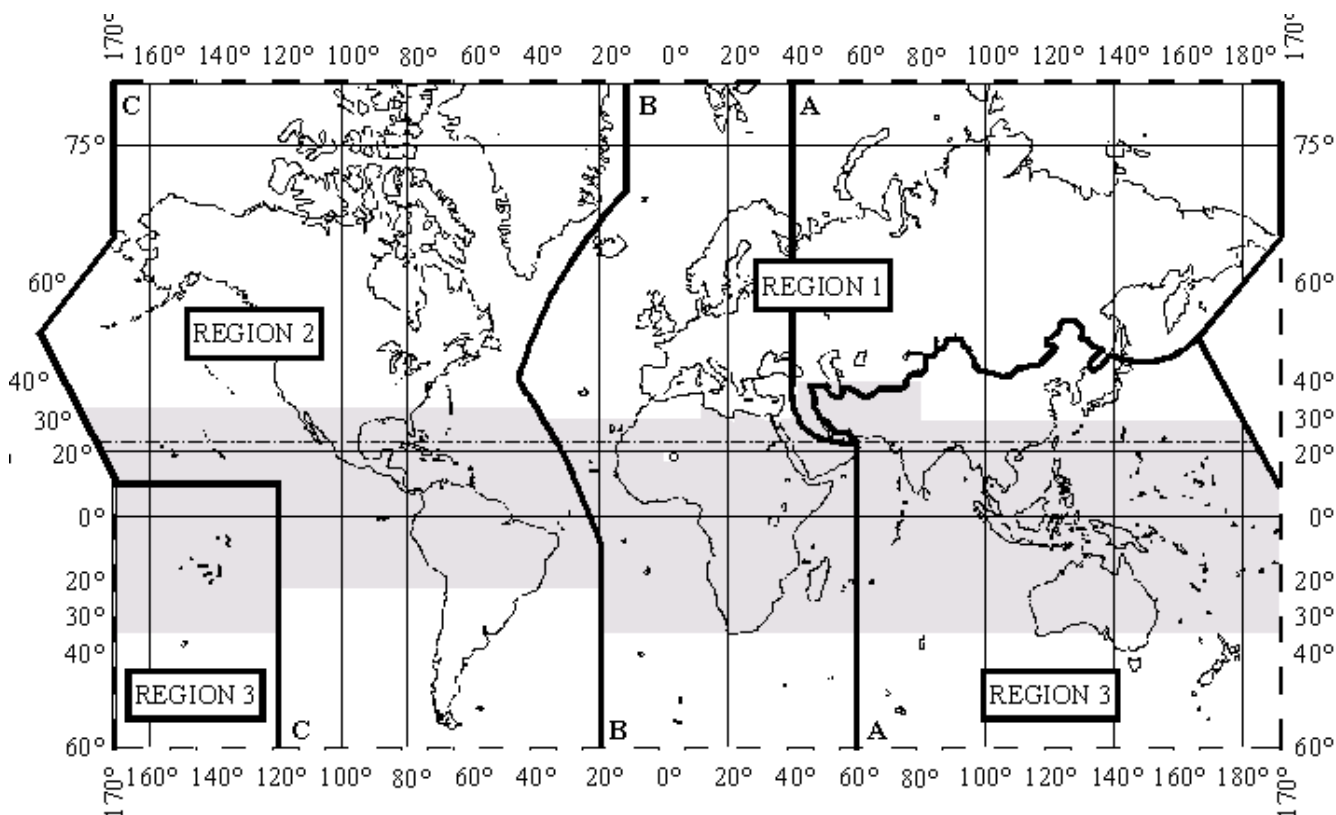
**Thomas vonDeak  
NASA Spectrum Management Office  
Glenn Research Center  
216-433-3277  
[Thomas.C.vonDeak@nasa.gov](mailto:Thomas.C.vonDeak@nasa.gov)**

**March 25, 2003**

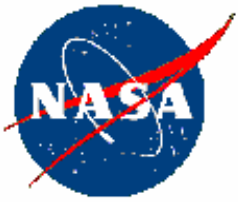


# Regions Defined in the ITU-R Radio Regulations

The ITU-R Radio Regulations (RR) divides the world into three Regions.



The shaded part represents the Tropical Zones as defined in Nos. S5.16 to S5.20 and S5.21.



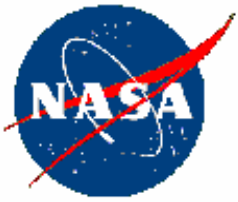
# Past NASA X-Band Workshops

- ◆ **Two Previous X-Band Workshops; both with a U.S. Domestic outlook and orientation.**
  - X-Band Workshop (II) 8025-8400 MHz, Goddard Space Flight Center, July 25-27, 1994
  - X-Band Workshop III 8025-8400 MHz, Vandenberg Air Force Base, June 21-22, 1995
- ◆ **Precipitated by the Land Remote Sensing Policy Act of 1992**
  - ◆ **Numerous U.S. non-Government EESS systems were expected as a result.**
- ◆ **Discussion on the national and international directions the U.S. Government should follow regarding new EESS systems in the 8025-8400 GHz and the impact on adjacent bands.**
- ◆ **Both workshops recognized the need to gain support of the Space Frequency Coordination Group (SFCG).**



# Past NASA X-Band Workshops

- ◆ **Past Workshop observations and actions since the workshops.**
  - ◆ **EESS (space-to-Earth) secondary allocation in Regions 1 & 3 in the 8025-8400 MHz band needs to be upgraded to primary.**
    - EESS (space-to-Earth) is now primary in all regions.
    - ITU-R Rec. F.1502 (2000) developed under WRC-97 Resolution 124. Provides for more restrictive pfd for GEO-EESS in Regions 1 & 3. May be considered at a future WRC for incorporation in the RRs.
  - ◆ **Spectrum needed to support high data rate downlink transmissions.**
    - EESS (space-to-Earth) primary allocation in all regions in the 25.5-27 GHz band achieved at WRC-97.
  - ◆ **EESS out-of-band emissions can cause problems to Deep Space Research.**
    - SFCG Rec. 14-3 (and subsequent revisions) created.
    - SFCG Rec. 21-2 (developed from SFCG Rec. 17-2R1) incorporated spectral emission mask for effective use of 8025-8400 MHz band and Deep Space Research protection in the adjacent 8400-8450 MHz band.
    - NASA Policy under development.

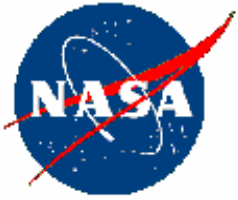


# Past NASA X-Band Workshops

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## However

- ◆ **No consensus of opinion reached on the level of congestion and interference. Therefore no consensus reached on the actions needed.**



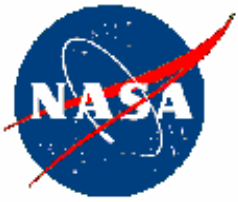
# Overview of Relevant Allocations for EESS Downlink Operations

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**X-Band (8025-8400 MHz)**

**Ka-Band (25.5-27 GHz)**

- Usage Considerations for the Two Allocated Bands
- ITU-R and U.S. Table Allocations

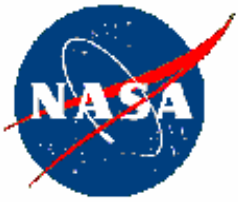


# Considerations for Allocations in the X-Band

- ◆ The 8025–8400 MHz band best accommodates low to moderate data rate EESS users with necessary bandwidths up to around 150 MHz.
  - ◆ The transmission of 300 MHz in X-Band is technically possible but not encouraged due to the difficulty in coordinating with the other users in this band.
- ◆ Unwanted emissions from Earth Exploration Satellite Service (EESS) (space-to-Earth) transmitters into the adjacent SRS deep space band (8400-8450 MHz) should be controlled per the guidelines established in Recommendation ITU-R SA.1157.
- ◆ Subject to PFD limits in Regions 1 & 3 per ITU-R RR 5.462A. Coordination of EESS earth stations with fixed systems may be difficult, especially in some Region 1 and 3 countries.

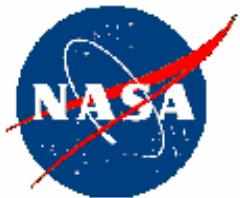


NASA Spectrum Management Office



# Considerations for Allocations in the Ka-Band

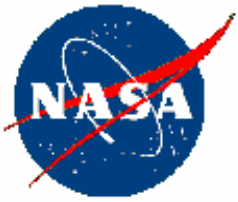
- ◆ The 22.55-23.55 GHz and 25.25-27.5 GHz bands are allocated to space-to-space links on a primary basis worldwide
- ◆ The 25.5-27 GHz band is allocated to EESS (space-to-Earth) links on a primary basis worldwide
- ◆ Bandwidth allocations in the Ka-Band allow for higher data rate telemetry transmissions
- ◆ Narrower antenna beamwidths reduce potential for interference
- ◆ Non-Government EESS use of 25.5-27 GHz is secondary in the US



# Ka-Band Allocations

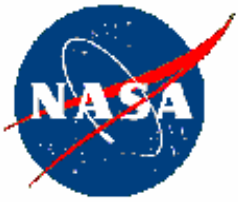
International Table			United States Table	
Region 1	Region 2	Region 3	Federal Government	Non-Federal Government
22.21-22.5 EARTH EXPLORATION-SATELLITE (passive) FIXED MOBILE except aeronautical mobile RADIO ASTRONOMY SPACE RESEARCH (passive) S5.149 S5.532			22.21-22.5 EARTH EXPLORATION-SATELLITE (passive) FIXED MOBILE except aeronautical mobile RADIO ASTRONOMY SPACE RESEARCH (passive) S5.149 US263	
23.6-24 EARTH EXPLORATION-SATELLITE (passive) RADIO ASTRONOMY SPACE RESEARCH (passive) S5.340			23.6-24 EARTH EXPLORATION-SATELLITE (passive) RADIO ASTRONOMY US74 SPACE RESEARCH (passive) US246	
24.05-24.25 RADIOLOCATION Amateur Earth exploration-satellite (active) S5.150			24.05-24.25 RADIOLOCATION US110 G59 Earth exploration-satellite (active) S5.150	24.05-24.25 Radiolocation US110 Amateur Earth exploration-satellite (active) S5.150
25.25-25.5 FIXED INTER-SATELLITE S5.536 MOBILE Standard frequency and time signal-satellite (Earth-to-space)			25.25-25.5 FIXED INTER-SATELLITE S5.536 MOBILE Standard frequency and time signal-satellite (Earth-to-space)	25.25-27 Standard frequency and time signal-satellite (Earth-to-space) Earth exploration-satellite (space-to-space)
25.5-27 EARTH EXPLORATION-SATELLITE (space-to-Earth) S5.536A S5.536B FIXED INTER-SATELLITE S5.536 MOBILE Standard frequency and time signal-satellite (Earth-to-space)			25.5-27 FIXED INTER-SATELLITE S5.536 MOBILE Earth Exploration Satellite* (space-to-Earth) Standard frequency and time signal-satellite (Earth-to-space)	

\*The EESS allocation for this band is under consideration for change in the US. NASA anticipates EESS to have Government primary status when the US process is complete and further anticipates that this will occur before the end of the year 2003.



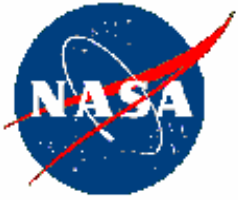
# Annexes

- ◆ **On-Line Spectrum Management Resources**
- ◆ **Power Flux Density (PFD) Limits: Band by Band**
- ◆ **ITU-R Footnotes Referenced in Previous Tables**
- ◆ **US Footnotes Referenced in Previous Tables**



# On-Line Spectrum Management Resources

- ◆ NTIA Office of Spectrum Management Web Site
  - ◆ <http://www.ntia.doc.gov>
  - ◆ *NTIA Manual of Regulations & Procedures for Federal Radio Frequency Management* available for download in Adobe Acrobat Portable Document Format (PDF) <http://www.ntia.doc.gov/osmhome/redbook/redbook.html>
    - Chapter 4. Allocations, Allotments and Plans
    - Chapter 5. Spectrum Standards
    - Chapter 10. Procedures for the Review of Telecommunication Systems for Frequency Availability and Electromagnetic Compatibility (EMC)
- ◆ ITU Web Site
  - ◆ <http://www.itu.int>
  - ◆ Overview of the ITU *Radio Regulations* <http://www.itu.int/sns/radreg.html>
- ◆ FCC Web Site
  - ◆ <http://www.fcc.gov/>
  - ◆ FCC's Table of Frequency Allocations  
<http://www.fcc.gov/oet/spectrum/table/fcctable.pdf>



# Power Flux Density (PFD) Limits Band by Band

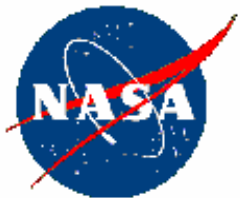
## ◆ PFD in any 4 kHz band within the band 8025-8500 MHz:

$\rho = -150$	$0 \leq \delta < 5^\circ$
$\rho = -150 + 0.5 (\delta - 5)$	$5^\circ \leq \delta < 25^\circ$
$\rho = -140$	$25^\circ \leq \delta < 90^\circ$

## ◆ PFD in any 1 MHz band within the 25.25-27.5 GHz band:

$\rho = -115$	$0 \leq \delta < 5^\circ$
$\rho = -115 + 0.5 (\delta - 5)$	$5^\circ \leq \delta < 25^\circ$
$\rho = -105$	$25^\circ \leq \delta < 90^\circ$

Units for  $\rho$  are  $dB(W/m^2)$        $\delta$  is the elevation angle

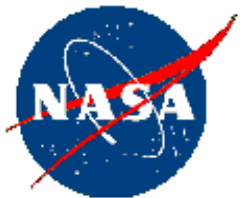


# ITU-R Footnotes Referenced in Previous Tables

**5.149** In making assignments to stations of other services to which the bands:

13 360-13 410 kHz,	4 950-4 990 MHz,	76-86 GHz,
25 550-25 670 kHz,	4 990-5 000 MHz,	92-94 GHz,
37.5-38.25 MHz,	6 650-6 675.2 MHz,	94.1-100 GHz,
73-74.6 MHz in Regions 1 and 3,	10.6-10.68 GHz,	102-109.5 GHz,
150.05-153 MHz in Region 1,	14.47-14.5 GHz,	111.8-114.25 GHz,
322-328.6 MHz,	22.01-22.21 GHz,	128.33-128.59 GHz,
406.1-410 MHz,	22.21-22.5 GHz,	129.23-129.49 GHz,
608-614 MHz in Regions 1 and 3,	22.81-22.86 GHz,	130-134 GHz,
1 330-1 400 MHz,	23.07-23.12 GHz,	136-148.5 GHz,
1 610.6-1 613.8 MHz,	31.2-31.3 GHz,	151.5-158.5 GHz,
1 660-1 670 MHz,	31.5-31.8 GHz in Regions 1 and 3,	168.59-168.93 GHz,
1 718.8-1 722.2 MHz,	36.43-36.5 GHz,	171.11-171.45 GHz,
2 655-2 690 MHz,	42.5-43.5 GHz,	172.31-172.65 GHz,
3 260-3 267 MHz,	42.77-42.87 GHz,	173.52-173.85 GHz,
3 332-3 339 MHz,	43.07-43.17 GHz,	195.75-196.15 GHz,
3 345.8-3 352.5 MHz,	43.37-43.47 GHz,	209-226 GHz,
4 825-4 835 MHz,	48.94-49.04 GHz,	241-250 GHz,
		252-275 GHz

are allocated, administrations are urged to take all practicable steps to protect the radio astronomy service from harmful interference. Emissions from spaceborne or airborne stations can be particularly serious sources of interference to the radio astronomy service (see Nos. **4.5** and **4.6** and Article **29**). (WRC-2000)



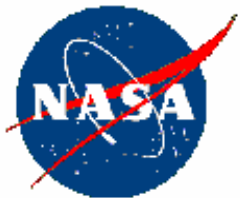
# ITU-R Footnotes Referenced in Previous Tables (continued)

**5.150**

The following bands:

13 553-13 567 kHz	(centre frequency 13 560 kHz),
26 957-27 283 kHz	(centre frequency 27 120 kHz),
40.66-40.70 MHz	(centre frequency 40.68 MHz),
902-928 MHz in Region 2	(centre frequency 915 MHz),
2 400-2 500 MHz	(centre frequency 2 450 MHz),
5 725-5 875 MHz	(centre frequency 5 800 MHz), and
24-24.25 GHz	(centre frequency 24.125 GHz)

are also designated for industrial, scientific and medical (ISM) applications. Radiocommunication services operating within these bands must accept harmful interference which may be caused by these applications. ISM equipment operating in these bands is subject to the provisions of No. **15.13**.



# ITU-R Footnotes Referenced in Previous Tables (continued)

**5.340**

All emissions are prohibited in the following bands:

1 400-1 427 MHz,  
2 690-2 700 MHz,  
10.68-10.7 GHz,  
15.35-15.4 GHz,  
23.6-24 GHz,  
31.3-31.5 GHz,  
31.5-31.8 GHz,  
48.94-49.04 GHz,  
50.2-50.4 GHz,  
52.6-54.25 GHz,  
86-92 GHz,  
100-102 GHz,  
109.5-111.8 GHz,  
114.25-116 GHz,  
148.5-151.5 GHz,  
164-167 GHz,  
190-191.8 GHz,  
200-209 GHz,  
226-231.5 GHz,  
250-252 GHz.

except those provided for by Nos. **5.421** and **5.422**,  
except those provided for by No. **5.483**,  
except those provided for by No. **5.511**,

in Region 2,  
from airborne stations,  
except those provided for by No. **5.555A**,

except those provided for by No. **5.563**,

(WRC-2000)



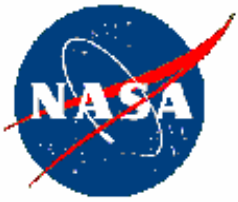
# ITU-R Footnotes Referenced in Previous Tables (continued)

**5.462A** In Regions 1 and 3 (except for Japan), in the band 8 025-8 400 MHz, the earth exploration-satellite service using geostationary satellites shall not produce a power flux-density in excess of the following provisional values for angles of arrival ( $\theta$ ), without the consent of the affected administration:

-174 dB(W/m <sup>2</sup> ) in a 4 kHz band	for $0^\circ$	$\leq \theta < 5^\circ$
-174 + 0.5 ( $\theta - 5$ ) dB(W/m <sup>2</sup> ) in a 4 kHz band	for $5^\circ$	$\leq \theta < 25^\circ$
-164 dB(W/m <sup>2</sup> ) in a 4 kHz band	for $25^\circ$	$\leq \theta \leq 90^\circ$

These values are subject to study under Resolution **124 (WRC-97)**. (WRC-97)

**5.463** Aircraft stations are not permitted to transmit in the band 8 025-8 400 MHz. (WRC-97)



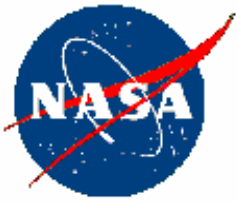
# ITU-R Footnotes Referenced in Previous Tables (continued)

**5.532** The use of the band 22.21-22.5 GHz by the Earth exploration-satellite (passive) and space research (passive) services shall not impose constraints upon the fixed and mobile, except aeronautical mobile, services.

**5.536** Use of the 25.25-27.5 GHz band by the inter-satellite service is limited to space research and Earth exploration-satellite applications, and also transmissions of data originating from industrial and medical activities in space.

**5.536A** Administrations installing Earth exploration-satellite service earth stations cannot claim protection from stations in the fixed and mobile services operated by neighbouring administrations. In addition, earth stations operating in the Earth exploration-satellite service should take into account Recommendation ITU-R SA.1278. (WRC-2000)

**5.536B** In Germany, Saudi Arabia, Austria, Belgium, Brazil, Bulgaria, China, Korea (Rep. of), Denmark, Egypt, United Arab Emirates, Spain, Estonia, Finland, France, Hungary, India, Iran (Islamic Republic of), Ireland, Israel, Italy, Jordan, Kenya, Kuwait, Lebanon, Libya, Liechtenstein, Lithuania, Moldova, Norway, Oman, Uganda, Pakistan, the Philippines, Poland, Portugal, Syria, Slovakia, the Czech Rep., Romania, the United Kingdom, Singapore, Sweden, Switzerland, Tanzania, Turkey, Viet Nam and Zimbabwe, earth stations operating in the Earth exploration-satellite service in the band 25.5-27 GHz shall not claim protection from, or constrain the use and deployment of, stations of the fixed and mobile services. (WRC-97)



# US Footnotes Referenced in Previous Tables

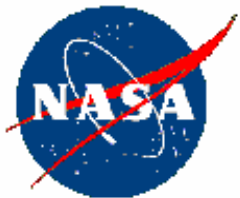
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**G59**--In the bands 902-928 MHz, 3100-3300 MHz, 3500-3700 MHz, 5250-5350 MHz, 8500-9000 MHz, 9200-9300 MHz, 13.4-14.0 GHz, 15.7-17.7 GHz and 24.05-24.25 GHz, all Government non-military radiolocation shall be secondary to military radiolocation, except in the subband 15.7-16.2 GHz airport surface detection equipment (ASDE) is permitted on a co-equal basis subject to coordination with the military departments

**G104**--In the bands 7450-7550 and 8175-8215 MHz, it is agreed that although the military space radio communication systems, which include earth stations near the proposed meteorological-satellite installations will precede the meteorological-satellite installations, engineering adjustments to either the military or the meteorological-satellite systems or both will be made as mutually required to assure compatible operations of the systems concerned.

**G117**--In the bands 7250-7750, 7900-8400 MHz and 17.8-21.2, 30-31, 39.5-40.5, 43.5-45.5 and 50.4-51.4 GHz the Government fixed-satellite and mobile-satellite services are limited to military systems.

**US110**--In the frequency bands 3100-3300 MHz, 3500-3700 MHz, 5250-5350 MHz, 8500-9000 MHz, 9200-9300 MHz, 9500-10000 MHz, 13.4-14.0 GHz, 15.7-17.3 GHz, 24.05-24.25 GHz and 33.4-36 GHz, the non-Government radiolocation service shall be secondary to the Government radiolocation service and to airborne doppler radars at 8800 MHz, and shall provide protection to airport surface detection equipment (ASDE) operating between 15.7-16.2 GHz



# US Footnotes Referenced in Previous Tables (continued)

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**US211**--In the bands 1670-1690, 5000-5250 MHz, and 10.7-11.7, 15.1365-15.35, 15.4-15.7, 22.5-22.55, 24-24.05, 31.0-31.3, 31.8-32, 40.5-42.5, 84-86, 102-105, 116-126, 151-164, 176.5-182, 185-190, 231-235, 252-265 GHz, applicants for airborne or space station assignments are urged to take all practicable steps to protect radio astronomy observations in the adjacent bands from harmful interference; however, US74 applies.

**US246**--No stations will be authorized to transmit in the bands 608-614 MHz, 1400-1427 MHz, 1660.5-1668.4 MHz, 2690-2700 MHz, 4990-5000 MHz, 10.68-10.70 GHz, 15.35-15.40 GHz, 23.6-24.0 GHz, 31.3-31.8 GHz, 51.4-54.25 GHz, 58.2-59.0 GHz, 64-65 GHz, 86-92 GHz, 100-102 GHz, 105-116 GHz, 164-168 GHz, 182-185 GHz and 217-231 GHz

**US258**--In the band 8025-8400 MHz, the non-Government earth exploration-satellite service (space-to-Earth) is allocated on a primary basis. Authorizations are subject to a case-by-case electromagnetic compatibility analysis.

**US263**--In the frequency bands 21.2-21.4, 22.21-22.5, 36-37, 50.2-50.4, 54.25-58.2, 116-126, 150-151, 174.5-176.5, 200-202 and 235-238 GHz, the Space Research and the Earth Exploration-Satellite Services shall not receive protection from the Fixed and Mobile Services operating in accordance with the Table of Frequency Allocations.